

1. (Amended) A laterally translatable pressure staged rotary [shaft] sealing mechanism comprising:

(a) a housing having a portion thereof [being] exposed to a first fluid at a pressure P1;

(b) a relatively rotatable [surface] member being located for relative rotation with respect to said housing;

(c) laterally translatable annular seal carrier means having laterally translatable movement relative to said housing responsive to lateral movement of said relatively rotatable [surface] member;

(d) first and second [annular resilient] rotary sealing elements being supported in axially spaced relation by said laterally translatable annular seal carrier means and having [interference] pressure sealing relation with said laterally translatable annular seal carrier means and said relatively rotatable [surface] member and defining a staging pressure chamber between said first and second [annular resilient] rotary sealing elements; [and]

(e) a [means] staging fluid supply communicating a second fluid at a staging pressure P2 to said staging pressure chamber, said staging [at a] pressure P2 being [a fraction of] less than said pressure P1; and

(f) a sliding seal maintaining sliding sealing engagement with said laterally translatable annular seal carrier means.

2. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

(a) said laterally translatable annular seal carrier means being first and second seal carriers respectively supporting said first and second [annular resilient] rotary sealing elements; and

(b) at least one of said first and second seal carriers being substantially hydraulically force balanced in the axial direction so as to permit lateral translation of at least one of said first and second seal carriers regardless of the magnitude of pressures P1 and P2.

3. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 2, comprising:

(a) a bulkhead being located in sealed relation to said housing and defining axially spaced annular seal carrier recesses; and

(b) said first and second seal carriers being located within said axially spaced annular seal carrier recesses.

4. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 3, comprising:

said bulkhead being substantially hydraulically force balanced in the radial direction.

5. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

said first and second [annular resilient] rotary sealing elements establishing substantially equal sealing diameters with said relatively rotatable [surface] member.

6. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

said first and second [annular resilient] rotary sealing elements establishing unequal sealing diameters with said relatively rotatable [surface] member.

7. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

(a) a first fluid circulation passage for circulating said first fluid at said pressure P1 for cooling of said first [annular resilient] rotary sealing element;

(b) a second fluid circulation passage for circulating said second fluid at said pressure P2 within said staging pressure chamber for cooling of said first and second [annular resilient] rotary sealing elements; and

(c) means circulating said first and second fluids within respective first and second fluid circulation passages.

8. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

(a) a source of circulating coolant fluid at [low] a pressure lower than said pressure P2 of said second fluid;

(b) an outboard seal establishing low pressure sealing with respect to said relatively rotatable [surface] member and defining a cooling chamber outboard of said first and second [annular resilient] rotary sealing elements; and

(c) a cooling [passage] path being disposed in fluid circulation communication with said cooling chamber for circulation of said coolant fluid within said cooling chamber for cooling of said relatively rotatable [surface] member and said second [annular resilient] rotary sealing element.

9. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

(a) a fluid circulation path being defined within said staging pressure chamber; and

(b) a fluid circulation system circulating said second fluid through said fluid circulation path at said staging pressure P2 [for pressure staging and] for [removing heat buildup of] cooling said first and second [annular resilient] rotary sealing elements [responsive to relative rotation of said relatively rotatable surface].

10. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

(a) a bulkhead being disposed in sealed non-rotatable relation with respect to said housing and having a partition defining axially spaced annular seal carrier recesses;

(b) said laterally translatable annular seal carrier means being at least two seal carriers disposed within said axially spaced annular seal carrier recesses, each of said seal carriers defining an internal annular seal groove; and

(c) said [annular resilient] rotary sealing elements each being seated within a respective internal annular seal groove and having interference sealing with said respective internal annular seal groove and with said relatively rotatable [surface] member.

11. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

[a fluid circulation passage being defined by said housing for circulating said second fluid therethrough for removing heat build-up resulting from rotation of said relatively rotatable surface within said first and second annular resilient sealing elements.]

(a) said laterally translatable annular seal carrier means establishing a laterally sliding interface with a pressure retaining component; and

(b) at least one of said pressure retaining component and said laterally translatable annular seal carrier means having a low friction surface treatment for minimizing friction at said laterally sliding interface.

12. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

(a) [a sealing interface being defined by] engagement of said first and second [annular resilient] rotary sealing elements with said relatively rotatable [surface] member defining respective first and second sealing interfaces with said relatively rotatable member; and

(b) at least one of said first and second [annular resilient] rotary sealing elements [having] defining a non-circular hydrodynamic lubrication geometry [for] wedging [lubricant] one of said first and second fluids into one of said respective first and second sealing interfaces responsive to rotation of said relatively rotatable [surface] member for lubrication.

13. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

at least one journal bearing being defined by said laterally translatable annular seal carrier means and establishing a guiding relationship with said relatively rotatable [surface] member.

14. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 13, comprising:

(a) a said laterally translatable annular seal carrier means defining at least one opening therethrough;

(b) fluid circulation through said at least one opening; and

(c) said fluid circulation reducing pressure drop across said journal bearing.

15. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

bearing means positioning said laterally translatable annular seal carrier means with respect to said relatively rotatable [surface] member.

16. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

said laterally translatable annular seal carrier means being substantially hydraulic force balanced in the axial direction so as to permit lateral translation thereof regardless of the magnitude of pressure P1.

17. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

said laterally translatable annular seal carrier means being a single seal carrier supporting said first and second [annular resilient] rotary sealing elements and being substantially hydraulically force balanced in the axial direction so as to permit lateral translation of said seal carrier regardless of the magnitude of pressure P1.

18. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 1, comprising:

(a) said first fluid being a lubricant; and

(b) means circulating said first fluid for cooling of said first [and second annular resilient] rotary sealing element[s].

19. (Amended) A laterally translatable pressure staged [shaft] sealing mechanism comprising:

(a) a housing having a chamber being exposed to a first fluid at a pressure P1;  
(b) a relatively rotatable [surface] member being located for rotation with respect to said housing;

(c) laterally translatable annular seal carrier means being laterally movable relative to said housing responsive to lateral movement of said relatively rotatable [surface] member;

(d) first and second [annular resilient] rotary sealing elements being supported in axially spaced relation by said laterally translatable annular seal carrier means and having [interference] pressure sealing relation with said laterally translatable annular seal carrier means and with said relatively rotatable [surface] member and defining a pressure staging chamber [having a fluid at a pressure P1]; [and]

(e) [means communicating] a second fluid at a pressure P2 [into] within said pressure staging chamber, said pressure P2 being [a fraction of] less than said pressure P1;

(g) a sliding seal maintaining sliding sealing engagement with said laterally translatable annular seal carrier means; and

(h) said laterally translatable annular seal carrier means being substantially hydraulic force balanced in the axial direction so as to permit lateral translation thereof



regardless of the magnitude of pressure P1.

20. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 19, comprising:

- (a) a bulkhead defining axially spaced annular seal carrier recesses; [and]
- (b) said laterally translatable annular seal carrier means being at least two seal carriers disposed respectively within said axially spaced annular seal carrier recesses; and
- (c) [a force balancing system establishing substantially hydraulic force balancing of] said bulkhead being substantially hydraulically force balanced in the radial direction to minimize pressure induced deformation thereof.

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(cont)

21. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 19, comprising:

- (a) a bulkhead defining axially spaced annular seal carrier recesses; and
- (b) said laterally translatable annular seal carrier means being at least two seal carriers disposed respectively within said axially spaced annular seal carrier recesses.

22. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 19, comprising:

said [seal carriers] laterally translatable annular seal carrier means being substantially pressure balanced in the radial direction.

23. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 19, comprising:

(a) an outboard rotary seal establishing low pressure sealing with said relatively rotatable [surface] member and defining a cooling chamber outboard of said first and second rotary sealing elements;

(b) a cooling fluid at a pressure lower than said pressure P2 of said second fluid; and

(c) a cooling [passage] path being disposed in fluid circulation communication with said cooling chamber for circulation of said cooling [coolant] fluid within said cooling chamber for cooling.

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(10.4)

24. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 19, comprising:

a fluid circulation system circulating said second fluid within said pressure staging chamber for cooling at least one of said first and second annular resilient sealing elements.

25. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 19, comprising:

(a) [a sealing interface being defined by] engagement of said first and second [annular resilient] rotary sealing elements with said relatively rotatable [surface] member defining respective first and second sealing interfaces with said relatively rotatable member; and

(b) at least one of said first and second [annular resilient] rotary sealing elements [having] defining a non-circular hydrodynamic geometry [for] wedging [lubricant] one of said first and second fluids into one of said respective first and second sealing interfaces thereof [with said] responsive to rotation of said relatively rotatable [surface] member.

26.(Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 19, comprising:

said laterally translatable annular seal carrier means being a single seal carrier supporting said first and second [annular resilient] rotary sealing elements.

27. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 19, comprising:

(a) said first fluid being a lubricant; and

(b) means circulating said first fluid [within said seal housing] for cooling of said first [and second annular resilient] rotary sealing element[s].

28. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 19, comprising:

said pressure P2 being less than half of pressure P1.

29. (Amended) A high pressure laterally translatable pressure staged [shaft] sealing mechanism for sealing of a relatively rotatable [surface] member with respect to a housing and being exposed to a first fluid at a pressure P1, comprising:

- (a) a bulkhead means establishing axially spaced annular seal carrier recesses;
- (b) a plurality of seal carriers being located respectively within said axially spaced annular seal carrier recesses;
- (c) a plurality of [annular resilient] rotary seals being supported respectively by said [axially spaced annular] seal carriers [and having] for [interference] pressure retaining sealing with [said] a relatively rotatable [surface] member;
- (d) at least one annular staging chamber being defined between adjacent [annular resilient] rotary seals; and
- (e) at least a second fluid at a staging pressure P2 being [a fraction of] less than said pressure P1 and being in communication with said at least one staging chamber.

30. (Amended) The laterally translatable pressure staged [shaft] sealing mechanism of claim 29, comprising:

- (a) said plurality of [annular resilient] rotary seals being at least three annular resilient seals including a first [annular resilient] rotary seal and a last [annular resilient] rotary seal;
- (b) said first [annular resilient] rotary seal being exposed to a first [differential] pressure; and

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(continued) (c) said last [annular resilient] rotary seal being exposed to a [differential] last pressure which is less than said first [differential] pressure.

ADD THE FOLLOWING NEW CLAIM:

--31. The laterally translatable pressure staged sealing mechanism of claim 29, comprising:

(a) engagement of said first and second rotary sealing elements with said relatively rotatable member defining respective first and second sealing interfaces with said relatively rotatable member; and

A<sub>2</sub> (b) at least one of said first and second rotary sealing elements defining a non-circular hydrodynamic lubrication geometry wedging one of said first and second fluids into one of said respective first and second sealing interfaces responsive to rotation of said relatively rotatable member for lubrication. --

REMARKS

Reconsideration of this application is respectfully requested.

Regarding the Information Disclosure Statement, applicants have included herewith a fresh copy of the publication of Kalsi et al, which is considered legible. In the event any other references are considered illegible, it is requested that counsel for applicants be advised.

Additionally, since filing of the Information Disclosure Statements, other patents have issued to applicant's Assignee, which may be of interest to the present application. An additional